REVIEW OF THE BLUE ISLAND MUNICIPAL WATER AND ELECTRIC LIGHTING PLANT

BY

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THESIS

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THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

DIEFENBACH, ARTHUR GARFIELD

ENTITLED REVIEW OF BLUE ISLAND (ILL.) ELECTRIC POWER PLANT

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE

OF Bachelor of Science in Electrical Engineering

Morgan Brooks

HEAD OF DEPARTMENT OF Electrical Engineering

CONTENTS

Part I.

REVIEW OF THE BLUE ISLAND MUNICIPAL WATER AND ELETRIC LIGHTING PLANT.

The Blue Island Power plant is owned and operated by the City of Blue Island, Illinois. The purposes of the plant are to furnish water to the city, and to supply electric lights for streets, residences and business houses. The plant, as it now stands, is the result of intermittent enlargements to meet the increasing demands upon it.

The buildings are three in number, but joined together so as to almost have the appearance of one. They are constructed of common brick. The first building erected is now used by the fire department. It is two stories in height with a flat roof. The engine-dynamo room is in a two story, flat roofed building with basement. The floors in these buildings are of wood. The boiler room has a corrugated iron, gable roof. The arrangement of the buildings and their contents, together with dimensions, are given in the accompanying plans.

The boilers consist of four one hundred horse power, horizontal tubular boilers, run at a pressure of from 85 to 90 lbs. The products of combustion are carried to a six-foot steel smoke stack, 110 feet high. Two worthington feed pump with $7\frac{1}{2}$ " steam cylinder, 5 " water cylinder, and 6 " stroke are used to feed the boilers with river water and condensed steam from a feed water heater. This heater consists of a vertical cyclindrical shell through the centre of which passes, for two thirds the shells height, the exhaust

The dynamos consist of two 65 K.W. alternating current, 1100 volt National Eletric Co's machines, run at 1500 r.p.m; also a 120 K.W., 1100 volt, Warren inductor type machine run at 800 r.p.m all single phase. These dynamos are belt connected to the above engines.

The switch board is built mostly of wood. A marble panel for the Warren machine and one for one of the National machines and a wooden panel for the other national machine are set in the wooden switch board and have mounted on them the ammeters, voltmeters, potential indicators, switches, rheostats and ground detectors of their respective machines. The switches for the distribution of current to the different circuits are mounted on the space about the panels. Fuses for the various circuits and Wurts non-arcing arresters are mounted at the top of the switch board. See switchboard wiring diagram and photographs. From this diagram of connections it will be seen that current from any one of the dynamos can be switched to any feeder circuit.

The city streets are lighted by the Electric Appliance Co's 1200 candle power 6.8 ampere, enclosed series arc lamps, and by 32 candle power series incandescent lamps. These lamps (See drawing of city circuits and location of lamps) are arranged on three circuits. The current at the plant is stepped up to two thousand volts by two J.Holt Gates & Co's and one Westinghouse 15 K.W. transformers, one transformer for each of the three circuits. The circuits are regulated by three Manhattan General Construction Co's series, alternating regulators. Two of these circuits are protected by the Garton lightning arresters and the third by the Wurts non-arcing metal arrester.

Current is distributed to the residence and business districts by four two wire circuits from the plant at a pressure of about 1100 volts. By means of transformers the service current is taken into buildings at a secondary pressure of 52 volts. There are now in use 140 transformers of from 10 to 250 lights capacity each, with an aggregate capacity of 4845 lights.

The following is a table of expenses and returns of the plant for two years:

From April 1, 1901 to April 1, 1902.

Expenses.

Chief Engineer	$1500	
Assist. "	900	
3 Fireman	2160	
City Eletrician	1200	5760
4000 tons coal		8400
Hauling coal(Extra man & team)		1400
12 bbls Engine oil	258	
12 " Dynamo "	216	
2 Bales Waste	50	
Carbons	60	
300-32 c.p. Street lights	111	695
Feed Water		350
	Total	$16,605

Returns.

Light Receipts	7499.68
Water Tax	6367.59
	13867.27
Street Lights	2737.73
	16,605.00

From April 1, 1902 to April 1, 1903.

Expenses.

Salaries	$5760
4000 tons coal	8600
Hauling coal(Extra man & team)	1400
Supplies	695
Feed Water	350
	16,805

Returns.

Light Receipts.(Commercial)	$6448.81
Water Tax	5942.85
	12391.66
Street Lights.	4413.34
	16805.00

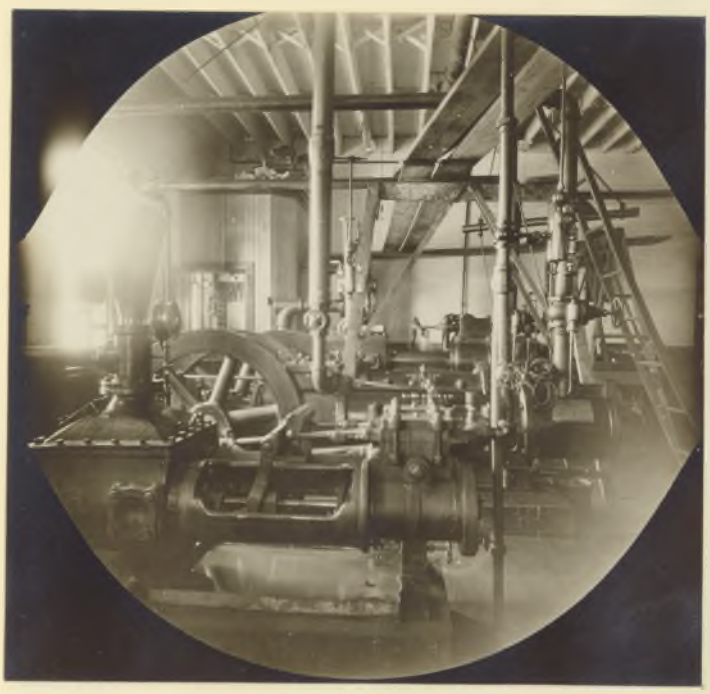
A valuation of $135,500 has been made on the real estate, buildings, installed machinery and connections and out side distributing system of the plant. As this valuation of the plant seems excessive for one of its size, and the plant could to-day be replaced for much less money by a plant located near a railroad, so as to bring about a saving of about twenty five cents drayage per ton of coal burned and a saving of about $350 a year for river water now purchased from the Rock Island Ry, it is advisable to build an up-to-date plant near the creek and railroad. The following is a design of a water and electric light plant suitable for the present and possible future needs of the city.

Views of the Blue Island Water and Electric Lighting Plant.

Blue Island Plant from the West.

Blue Island Plant from the East.

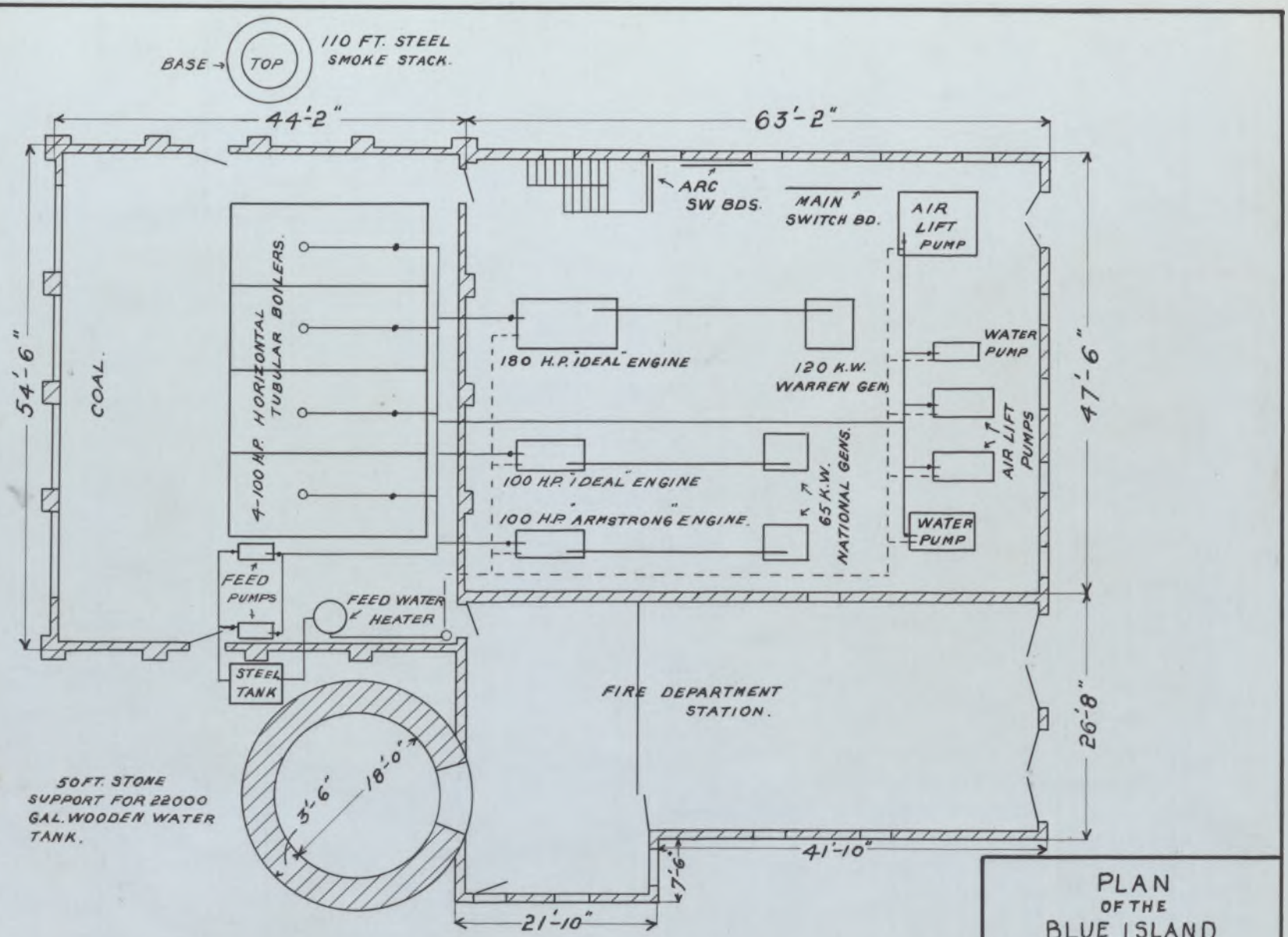
Large Air Lift.



Pumps and Small Air Lifts.

Armstrong and small "Ideal" Engines.

Large "Ideal" Engine.


BASE
TOP
110 FT. STEEL SMOKE STACK.
44'-2"
63'-2"
54'-6"
47'-6"
26'-8"
COAL.
4-100 H.P. HORIZONTAL TUBULAR BOILERS.
ARC SW BDS.
MAIN SWITCH BD.
AIR LIFT PUMP
180 H.P. "IDEAL" ENGINE
120 K.W. WARREN GEN.
WATER PUMP
AIR LIFT PUMPS
100 H.P. "IDEAL" ENGINE
100 H.P. "ARMSTRONG" ENGINE.
65 K.W. NATIONAL GENS.
WATER PUMP
FEED PUMPS
FEED WATER HEATER
STEEL TANK
FIRE DEPARTMENT STATION.
50 FT. STONE SUPPORT FOR 22000 GAL. WOODEN WATER TANK.
3'-6"
18'-0"
41'-10"
7'-6"
21'-10"
SCALE 1/16" = 1.0'
PLAN OF THE BLUE ISLAND MUNICIPAL PLANT 1903
A. G. Diefenbach '04.

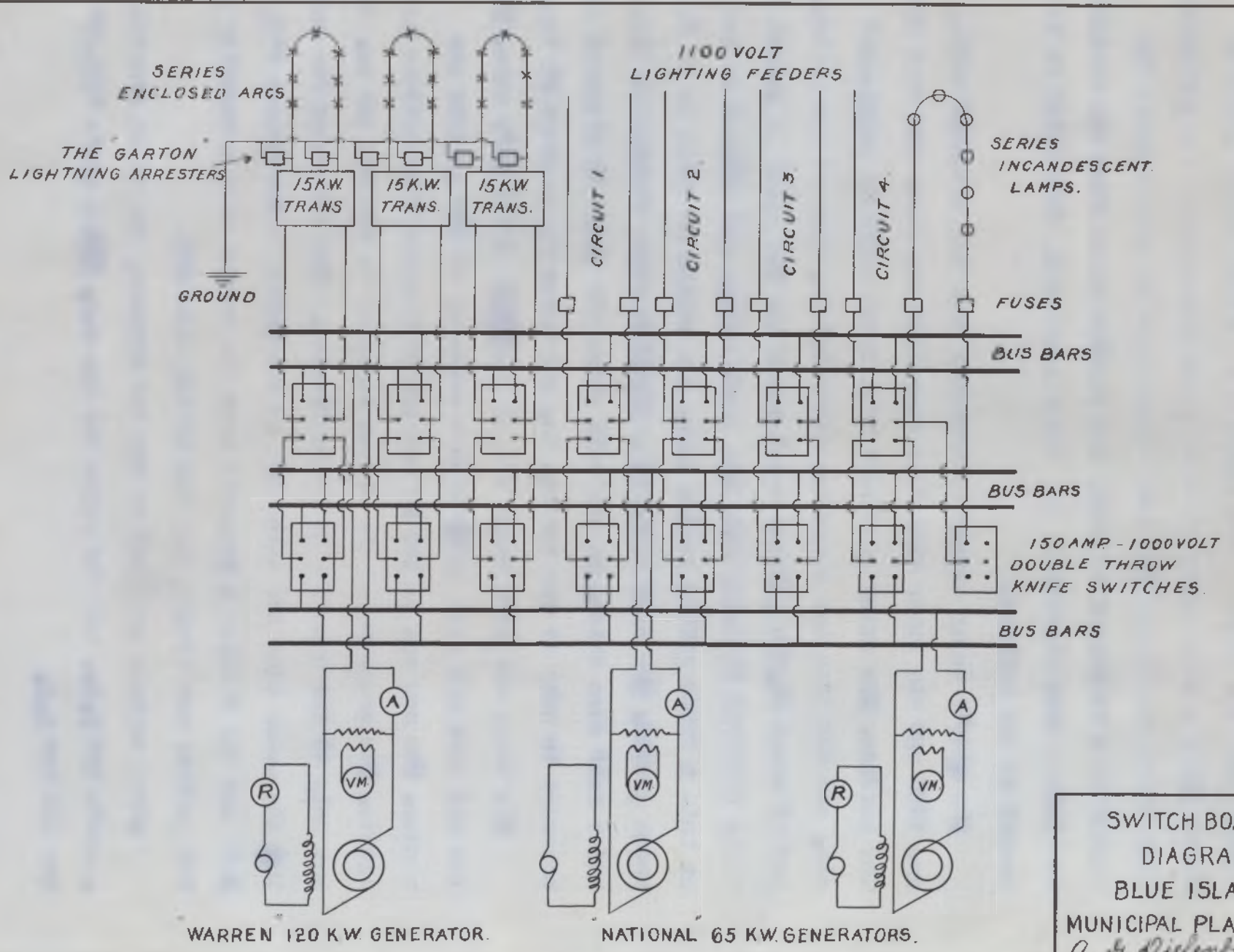
2(a)

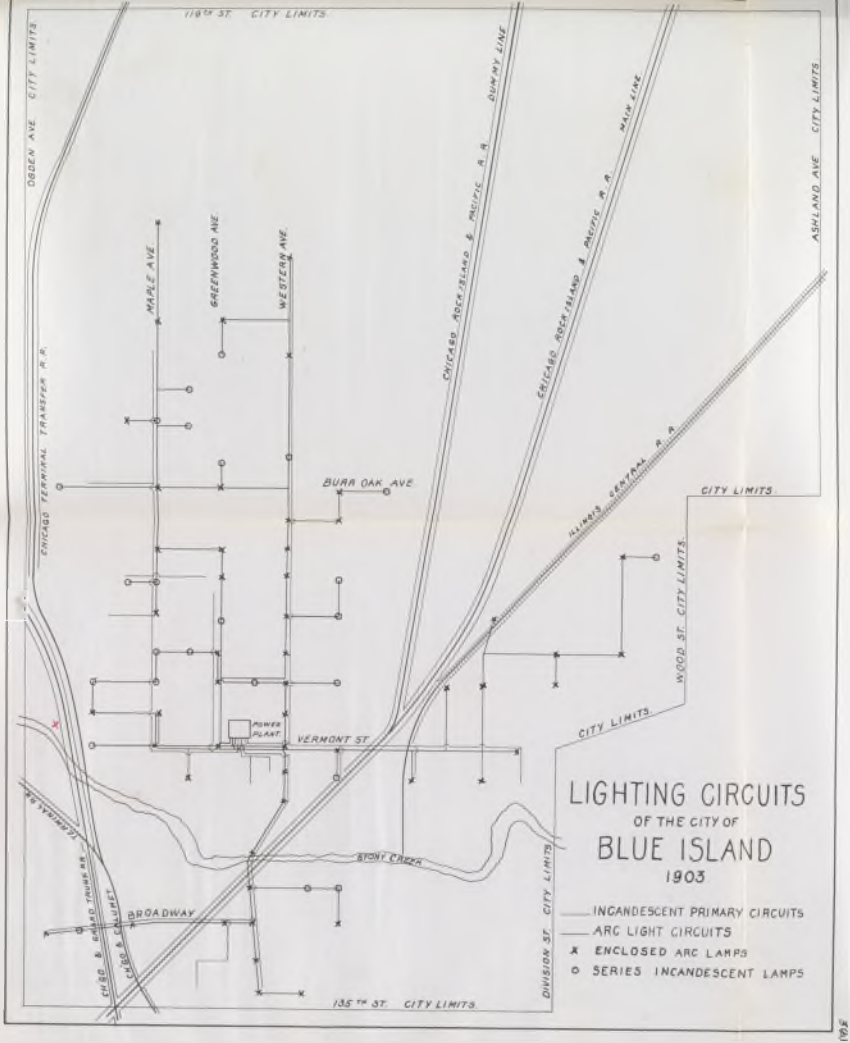
steam pipe. The steam shoots against an arched baffle plate on which plays a fine spray of river water coming out of a perforated pipe above the plate. The cold river water is stored above the heater in a boiler-plate tank, and surplus water from the heater is run into a tank similar to the first mentioned, from which it is pumped to the boilers.

The City's water supply is obtained from two artesian wells, one 1327 and the other 1409 feet deep with the water 150 feet from the surface. The water is raised from these wells by compressed air, and run into two cisterns, connected together at the bottom, and of about 51,500 gallons total capacity. The water is pumped from these cisterns directly into the water mains, and allowed to back up into a 22000 gallon wooden tank, the bottom of which is 50 feet above ground. The tank rests on a circular stone foundation three and a half foot thick. On the hill where the plant is situated the pressure is only 21 lbs per sq. in. and below it is about 41 lbs.

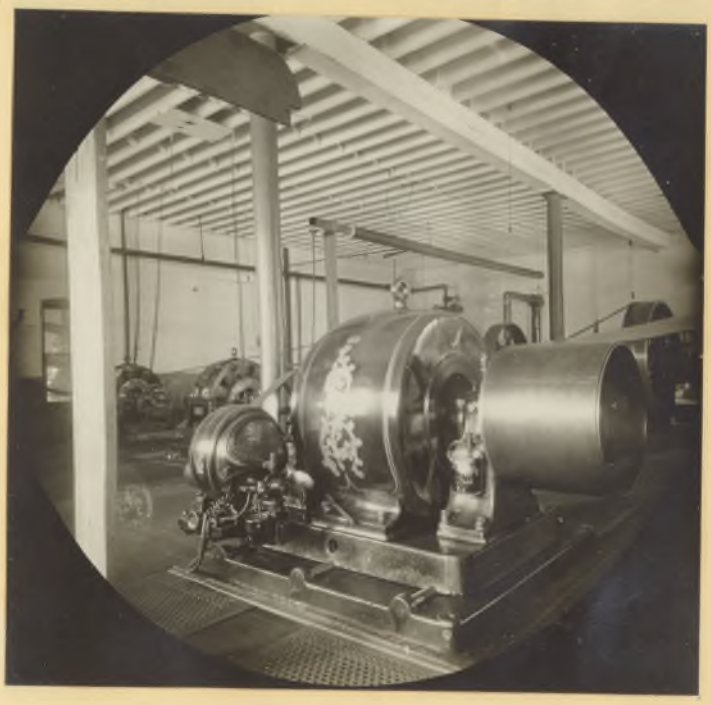
The three air lift pumps are of the Rand Drill Co's make. The two old ones are each 80 HP with a capacity of 150 gallons per minute. The new one is 180 HP and can lift about 1000 gallons per minute. The pressure of the air at starting is 100 lbs per sq. in. but only 85 lbs when the water is flowing. The two pumps for pumping the water into the mains are of the Volker & Felthousen M'fg Co's and the Wheeler & Tappan's make the former with a capacity of 700 gallons per minute, and the latter with 640.

Three engines are used to run the dynamos. One is an Armstrong & Son's 100 H.P., and the other two are A.L. Ide & Son's "Ideal" 100 and 180 H.P.


SERIES ENCLOSED ARCS
1100 VOLT LIGHTING FEEDERS
THE GARTON LIGHTNING ARRESTERS
15 K.W. TRANS.
15 K.W. TRANS.
15 K.W. TRANS.
CIRCUIT 1
CIRCUIT 2
CIRCUIT 3
CIRCUIT 4
SERIES INCANDESCENT LAMPS.
GROUND
FUSES
BUS BARS
BUS BARS
150 AMP. - 1000 VOLT DOUBLE THROW KNIFE SWITCHES.
BUS BARS
A
VM
R
WARREN 120 K.W. GENERATOR.
NATIONAL 65 K.W. GENERATORS.
SWITCH BOARD DIAGRAM
BLUE ISLAND
MUNICIPAL PLANT 1903
A. G. Diefenbach '04.


118TH ST. CITY LIMITS
OGDEN AVE CITY LIMITS
CHICAGO TERMINAL TRANSFER R.R.
MAPLE AVE
GREENWOOD AVE
WESTERN AVE
CHICAGO ROCK ISLAND & PACIFIC R.R. DUMMY LINE
CHICAGO ROCK ISLAND & PACIFIC R.R. MAIN LINE
ILLINOIS CENTRAL R.R.
ASHLAND AVE CITY LIMITS
BURR OAK AVE
CITY LIMITS
WOOD ST. CITY LIMITS
POWER PLANT
VERMONT ST.
CITY LIMITS
STONY CREEK
CHGO & CALUMET
CHGO & GRAND TRUNK R.R.
BROADWAY
DIVISION ST. CITY LIMITS
135TH ST. CITY LIMITS
LIGHTING CIRCUITS
OF THE CITY OF
BLUE ISLAND
1903
INCANDESCENT PRIMARY CIRCUITS
ARC LIGHT CIRCUITS
ENCLOSED ARC LAMPS
SERIES INCANDESCENT LAMPS

The two National Generators.



The Warren Generator.

Main Switch board.

Arc Light Transformers,
Manhatten Regulators, Ammeters and Lightning Arresters.

Part II.

PROPOSED LOCATION AND PLANS FOR A NEW BLUE ISLAND MUNICIPAL WATER AND ELECTRIC LIGHTING PLANT.

Location.

A good location for a new water and electric lighting plant for the City of Blue Island would be west of the Chicago & Grand Trunk R.R. and north of Vermont Street. Here coal could be taken directly from the cars to the boiler house bin, and soft water for the boilers could be pumped from the near-by creek. See tracing of the lighting circuits of the city and note red cross for the above location.

Plans.

The accompanying drawing shows the size of the proposed building, its contents and their arrangement, the city water reservoir and the coal storage bin. New apparatus is to be installed, excepting, perhaps, the new air lift now in use.

The contents of the new building is to be as follows:-

3-200 H.P. Water tube boilers with superheater) steam pressure 200 lbs)

2- Feed water pumps.

1 Vacuum pump.

1 motor driven centrifugal pump.

1 Surface condenser.

1 Air Lift.

2 City supply water pumps.

2-300 H.P., 200 A.W., 2 Phase De Laval steam turbine alternators.

Outside the building will be a hot well, a steel smoke stack 6 feet in diameter and 120 feet high, a 112,000 gal. city water supply concrete reservoir and a coal storage bin. Coal shoveled from the cars into this bin rolls down in front of the boilers.

It is proposed to continue using the old artesian wells. Compressed air piped to the wells will raise the water and deliver it to the new reservoir forty feet below the tops of the artesian wells. Thus it will be possible to do away with any attendant at the old plant.

The distribution system for lighting is to be three wire, two phase without transformers for 220 volt lamps.

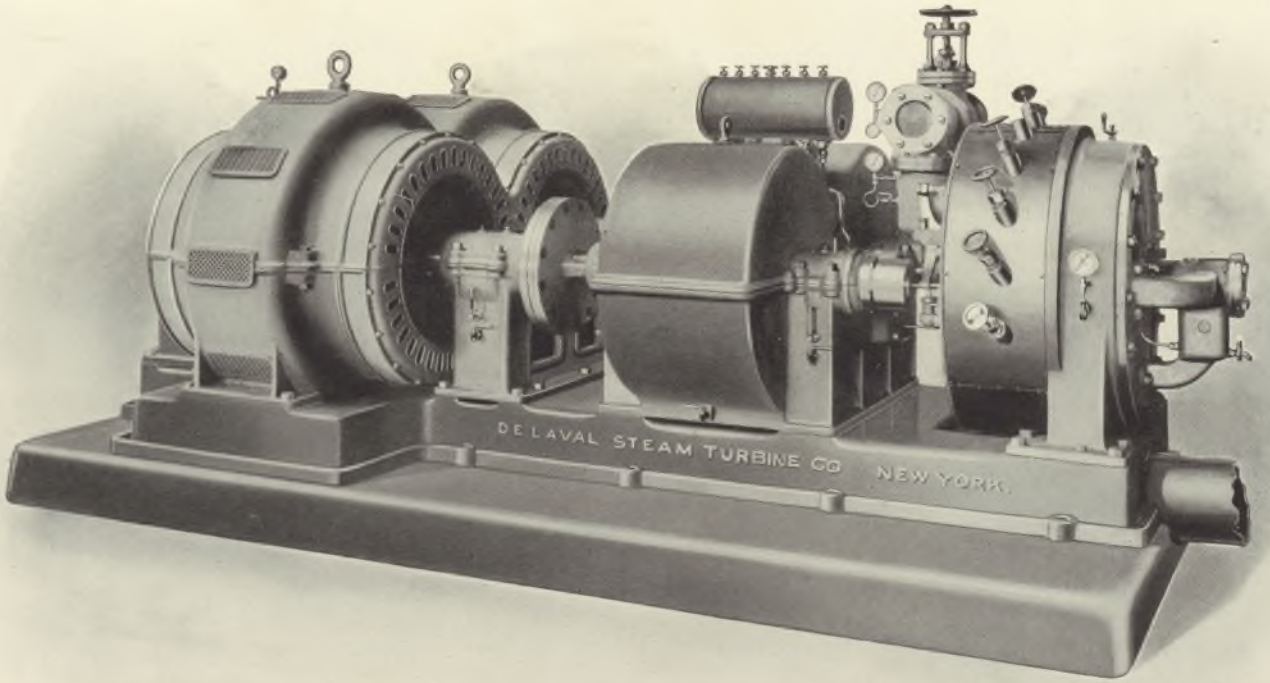
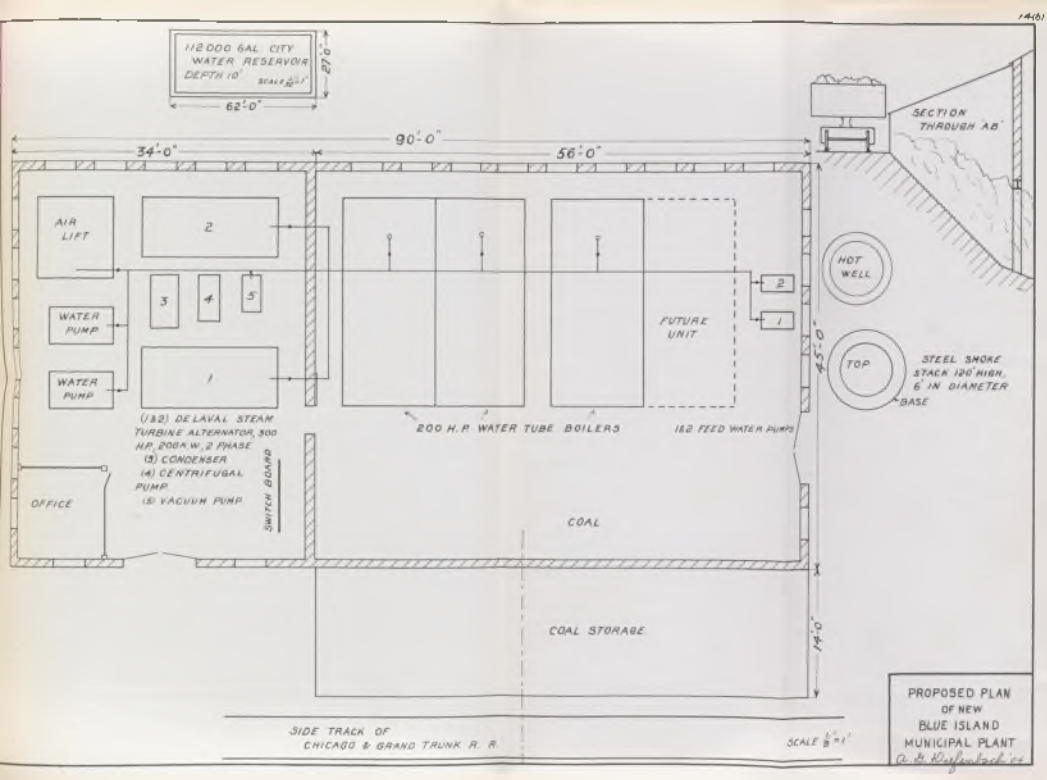


Fig. 25.—De Laval Steam Turbine Alternator, 300 H. P., 200 K. W., Two Phase.


112 000 GAL. CITY WATER RESERVOIR DEPTH 18'
SCALE 1/32"=1'
27'-0"
62'-0"
SECTION THROUGH AB
34'-0"
90'-0"
56'-0"
AIR LIFT
2
3
4
5
1
WATER PUMP
WATER PUMP
FUTURE UNIT
2
1
HOT WELL
TOP
45'-0"
STEEL SMOKE STACK 120' HIGH, 6' IN DIAMETER
BASE
(1&2) DE LAVAL STEAM TURBINE ALTERNATOR, 300 H.P. 200 K.W. 2 PHASE
(3) CONDENSER
(4) CENTRIFUGAL PUMP
(5) VACUUM PUMP
SWITCH BOARD
200 H.P. WATER TUBE BOILERS
1&2 FEED WATER PUMPS
OFFICE
COAL
COAL STORAGE
14'-0"
SIDE TRACK OF CHICAGO & GRAND TRUNK R. R.
SCALE 1/8"=1'
PROPOSED PLAN OF NEW BLUE ISLAND MUNICIPAL PLANT
D. H. Burnham '04

Part III.

ESTIMATED COST OF A NEW PLANT AND THE JUSTIFICATION FOR ITS ERECTION.

A new plant for the city is needed. The old plant has been in use for some time, and its equipment is not in good condition to give either first class or economical service. A new plant would effect a saving in several directions. The expense of hauling coal from the railroad to the old plant, a distance of three blocks, would be saved. As this expense now amounts to thirty-five cents per ton, allowing ten cents per ton for unloading the coal, a saving of at least twenty-five cents per ton would be made. Figuring on the amount of coal now burned, about $1000 would be saved on the item of hauling. The city now pays about $350 per year for river water purchased from the railroad. A plant located near the creek could pump its own water for the boilers and so save the amount paid to the railroad. At least $2000 will be saved on the coal bill on account of better efficiency of the new equipment. The sum saved by the new plant will then be in the neighborhood of $4350. By doing away with the transformer a sum of $1000 will be saved in transform losses in figuring the plant operated twelve hours a day. If the plant was operated all day, twice the amount would be saved. Figuring at the rate of ten per cent for depreciation and interest, the $4350 saved would make it advisable to construct a better plant to an increased amount not exceeding $43500.

The following is an estimate of the cost of a new plant:-

Land	$2000
Building	15000
3-200 H.P. Water Tube Boilers with superheater	12000
2 Feed Pumps.	200
1 Vacuum Pump	125
1 Surface Condenser	600
1 Centrifugal Pump and Motor.	200
2-200 K.W. De Leval Steam Turbine Alternators.	18000
Switchboard	500
2 City Water Supply Pumps.	2500
Piping	600
Reservoir.	600
Steel Smoke Stack.	1200
Hot Well.	75
Coal Storage Bin.	300
	$53900

By subtracting $43500, the amount on which the saving of the new plant will pay depreciation and interest charges, from $53900, the estimated cost of the new plant, a sum of $10,400 is left as the unproductive cost of the new plant. The sale of most the equipment of the old plant would reduce this cost still further.

Such new water and electric lighting plant as described in Part II is very much needed to ensure reliability of service, and since a considerable saving in operating expenses would be effected, a reduction in charges would stimulate rapid growth.